Advanced Light Armament for Combat Vehicles (ALACV) Summary Brief

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APO-Med Cal Special Projects

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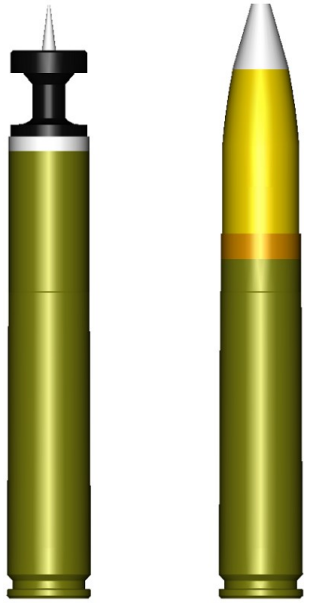
ALACV Program

- BACKGROUND:
  - ARDEC Approved STO in FY99
  - 4-Year Program (FY00-FY03)
  - Total Funding: $7.73M
- PURPOSE:
  - Develop New Technologies that Enhance the Lethality of Medium Caliber Tactical Munitions
    - Novel geometries or Alternative Tungsten Penetrator Materials for APFSDS Munitions
    - Improved Warhead Designs for A/B Munitions
  - Ensure Technologies are scalable to all calibers from 30mm to 60mm
- STRATEGY:
  - Develop Prototype Super40 Cartridge Designs for use as a Demonstrator Caliber

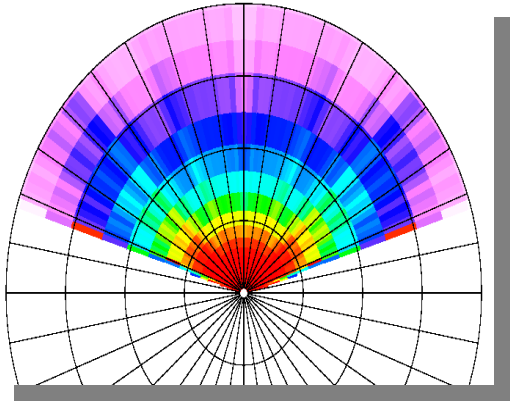


ALACV Program

- EXIT CRITERIA:

  - Armor Piercing (AP)
    - o Achieve a 30% increase in Behind Armor
      Effects (BAE) over a baseline 40mm APFSDS tungsten monolithic penetrator

  - Air Burst (A/B)
    - o Achieve a 400% increase in Lethal Area
      over a baseline 30mm HEPD (PGU-13B)
      round
      - Improve shape of Lethal Area of Current "Bat-Winged" Fragmentation

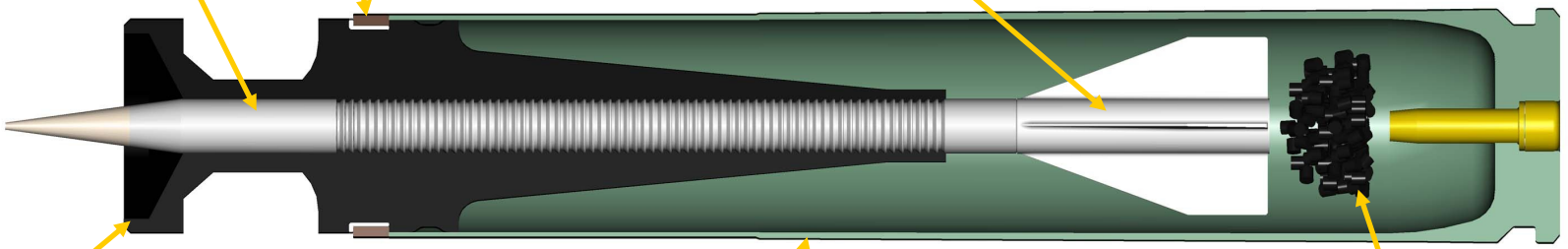


ALACV Super40 APFSDS-T Development "Team"

Tungsten Penetrator Cores: CCAC/AOT

Obturator: CCAC/GDOTS

MIM Fin: GDOTS (PROPRIETARY)



Aluminum Sabot: GDOTS (PROPRIETARY)

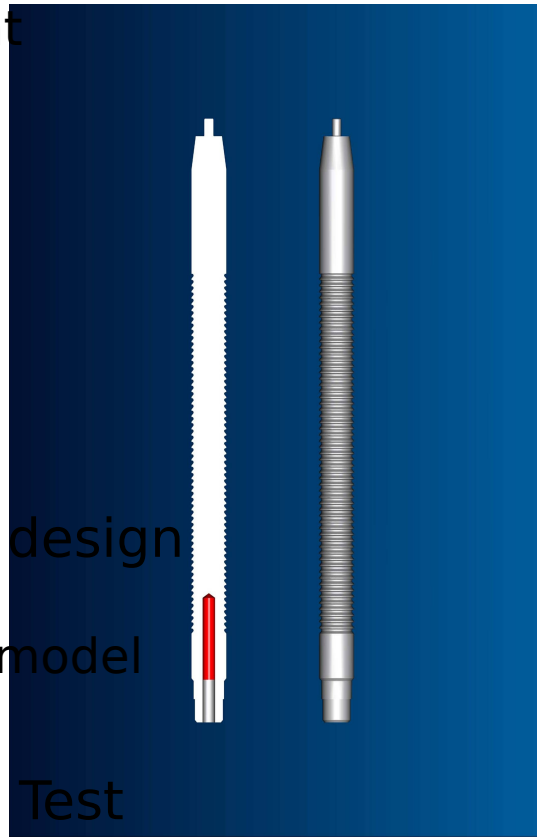
Propulsion System: CCAC/GDOTS (25mm M919)

Cartridge Case: CCAC/GDOTS (Santa Barbara)

- **Mk44 Weapons:** ATK GSC and PM AAAV
- **Target Assessments:** ARL
- **Demonstration Testing:** GDOTS
- **Funding: ARDEC Tech Base, DRPM-AAA, PM-MAS**

ALACV Super40 APFSDS-T
CY03 Accomplishments

- Changed L/D Profile of Baseline Core
  - Increased OD while maintaining constant Weight
  - Desired greater robustness during armor penetration
- Optimized Geometry of ENLE effect
  - Altered ID and depth of cavity
- Optimized Low Density filler for ENLE effect
  - Special blend of Nano-Aluminum
- Generated Lethality data for Gen-II penetrator design
  - performed in ARL's Terminal Ballistic Range
  - Frontal & Cardioid engagements using SQuASH model
  - used to verify STO compliance
- Built Gen-I assets, conducted Proof-of-Principle Test
  - with and w/o ENL effect
  - performed Aug 03 at Camden, Ark



ALACV Super40 APFSDS-T

Proof-Of-Principle Test

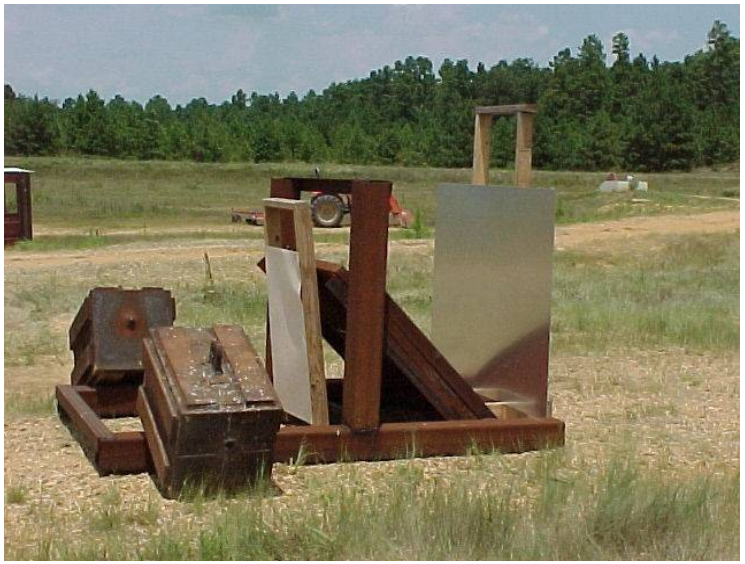
- 22 each Super40 APFSDS-T Cartridge Assemblies
  - All rounds utilized a Gen-1 penetrator core configuration
  - 17 rounds with monolithic cores
  - 5 rounds with a Gen-1 ENLE concept

Dispersion Testing

2000m MANN Barrel Test - 7 Super40 AP rounds w/ Mono Cores

337.5m MK44 Autogun Test - 10 Super40 AP rounds w/ Mono Cores

2 five-round bursts at 200spm



Strength of Design/Armor Penetration Testing

100m MANN Barrel Test

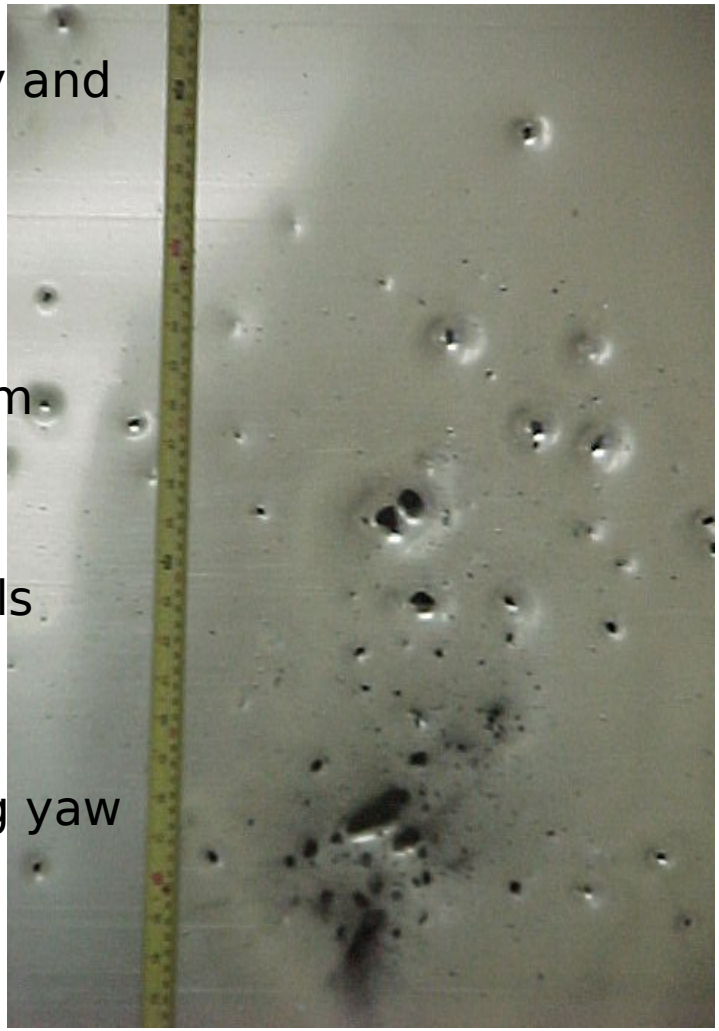
5 Super40 AP rounds w/ ENLE Cores (increasing Propellant Charge Weights)

2” RHA Armor Plate at 45 Deg Obliquity

ALACV Super40 APFSDS-T

Proof-Of-Principle Test

- All rounds demonstrated structural integrity and excellent launch and flight characteristics
- MANN Barrel Dispersion (Single Shot)
  - mean MV: 1222 mps (σ = 6.7mps)
  - 0.37 mils by 0.37 mils
  - mean Vel Decay (0-3000m): 130 mps/km
- MK44 Autogun Dispersion (200spm)
  - mean MV: 1216 mps (σ = 7.7mps)
  - Pooled Dispersion: 0.39 mils by 0.37 mils
- Strength of Design / Penetration
  - Variations in strike Vel: 1113-1202 mps
  - All rounds impacted target with ≤ 1 deg yaw
  - All rounds perforated the target
    - ENLE cores produced more BAD



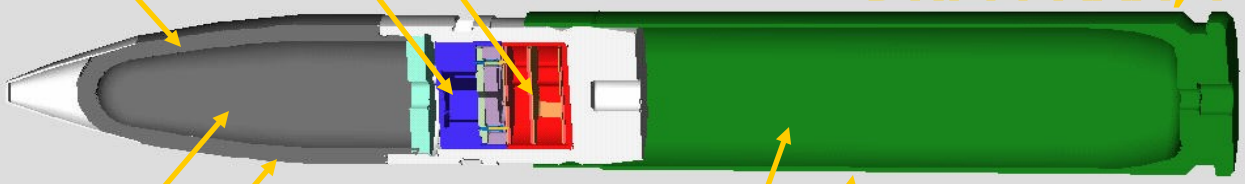
ALACV Super40 HEAB Development "Team"

Safe & Arm: CCAC Fuze Division

Turns Count Electronics: ATK (PROPRIETARY)

Warhead: CCAC/Warheads Div

- **Mk44 Weapons:** ATK GSC and PM AAAV
- **Target Assessments:** ARL, AMSAA and PM AAAV
- **Telemetry:** FSAC
- **Adv. Algorithm:** ARL Adelp
- **Demonstration Testing:** AT
- **Funding:** ARDEC Tech Base DRPM-AAA, PM-MAS



Explosive: CCAC/ATK

Cartridge Case: CCAC/ GDOTS (Santa Barbara)

Projectile/Trace: CCAC/GDOTS

Propulsion System: GDOTS (PROPRIETARY)

ALACV Super40 HEAB-T

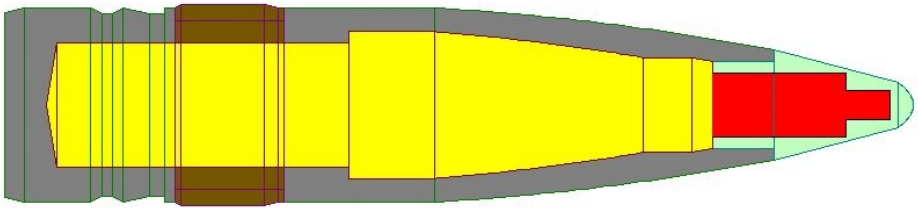
CY03 Accomplishments

- Finalized increased lethality (Gen-III) Warhead Design
- Performed static laboratory fragmentation tests
  - verified lethality gains through M&S
- Performed Arena Test
  - confirmed fragmentation data (distribution & initial velocities)
- Performed Lethality Assessment
  - used Arena data (w/ analytical firing tables, unit effects, error budg
  - CASRAD & FBAR models used to predict *"Probability of Incapacitatio*
- Compared results w/ M&S data from 30mm PGU13 HEPD
  - used outcome to verify compliance with STO
- Built Gen-I Assets and Conducted Proof-of-Principle Test
  - developed prototype fuzing usable with live warheads
  - Performed 3 Soft-Catch tests (May-Oct 03) to resolve technical issue
  - Final Demo conducted at ATPG, Elk River, MN in Dec 03

ALACV Super40 HEAB-T

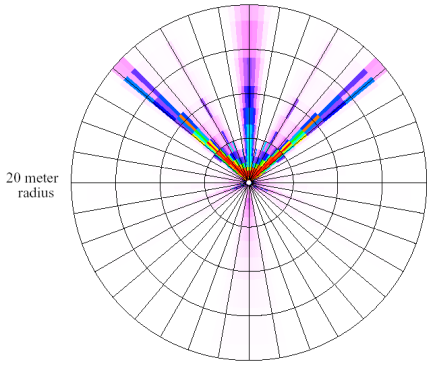
Lethality Modeling

30mm PGU-13 HEPD



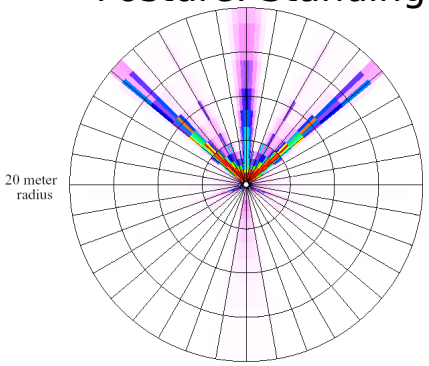
Probability of Incapac
Range: 1500m Burst Height: 0 ft

Posture: Prone



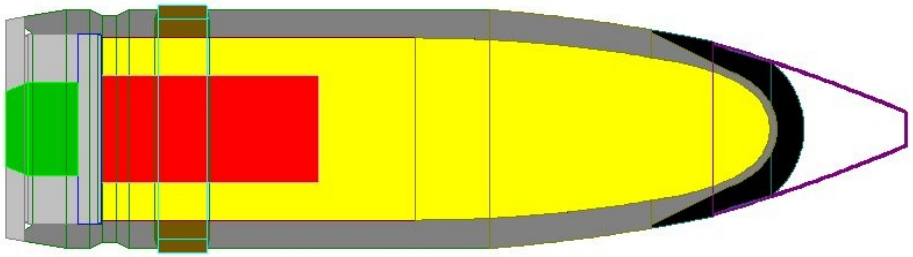
Lethal Area: 100%

Posture: Standing



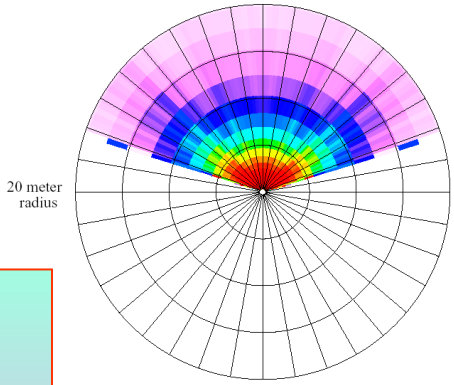
Lethal Area: 100%

40mm ALACV Gen III



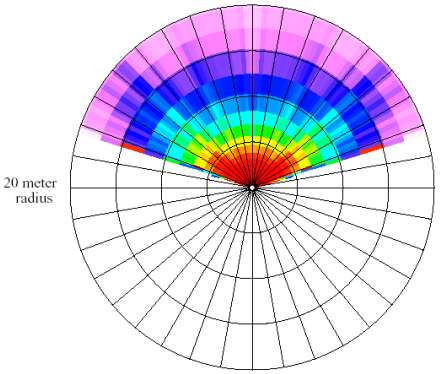
Probability of Incapacitation
Range: 1500m Burst Height: 4 ft

Posture: Prone



Lethal Area: 597%

Posture: Standing



Lethal Area: 471%

20-25% of increased lethal area - caliber size
75-80% of increased lethal area -

ALACV Super40 HEAB-T

Proof-Of-Principle Test

- 12 Full-Up Super40 AB-T Rounds w/ GEN-I Warheads
  - 6-Rounds from 40mm MANN Barrel
  - 6-Rounds from 40mm MK44 Autogun
    - 3-Rounds in S/S, 3-Rounds at 200spm
- Target Arrays:
  - 24-man dismounted Infantry Squad in a 60’ X 120’ Area
    - Alternating Standing and Prone Mannequins
    - Front of Array located 1500m from Weapon
  - ATGM (Anti-Tank Guided Missile) Site
    - 2 prone/protected Mannequins behind 1.2’ high sandbag wal
    - Front of wall located in middle of Infantry Squad
- All Mannequins wore std. Army issued Kevlar Flak jackets & Helmets

ALACV Super40 HEAB-T

Proof-Of-Principle Test

ALACV Super40 HEAB-T

Proof-Of-Principle Test

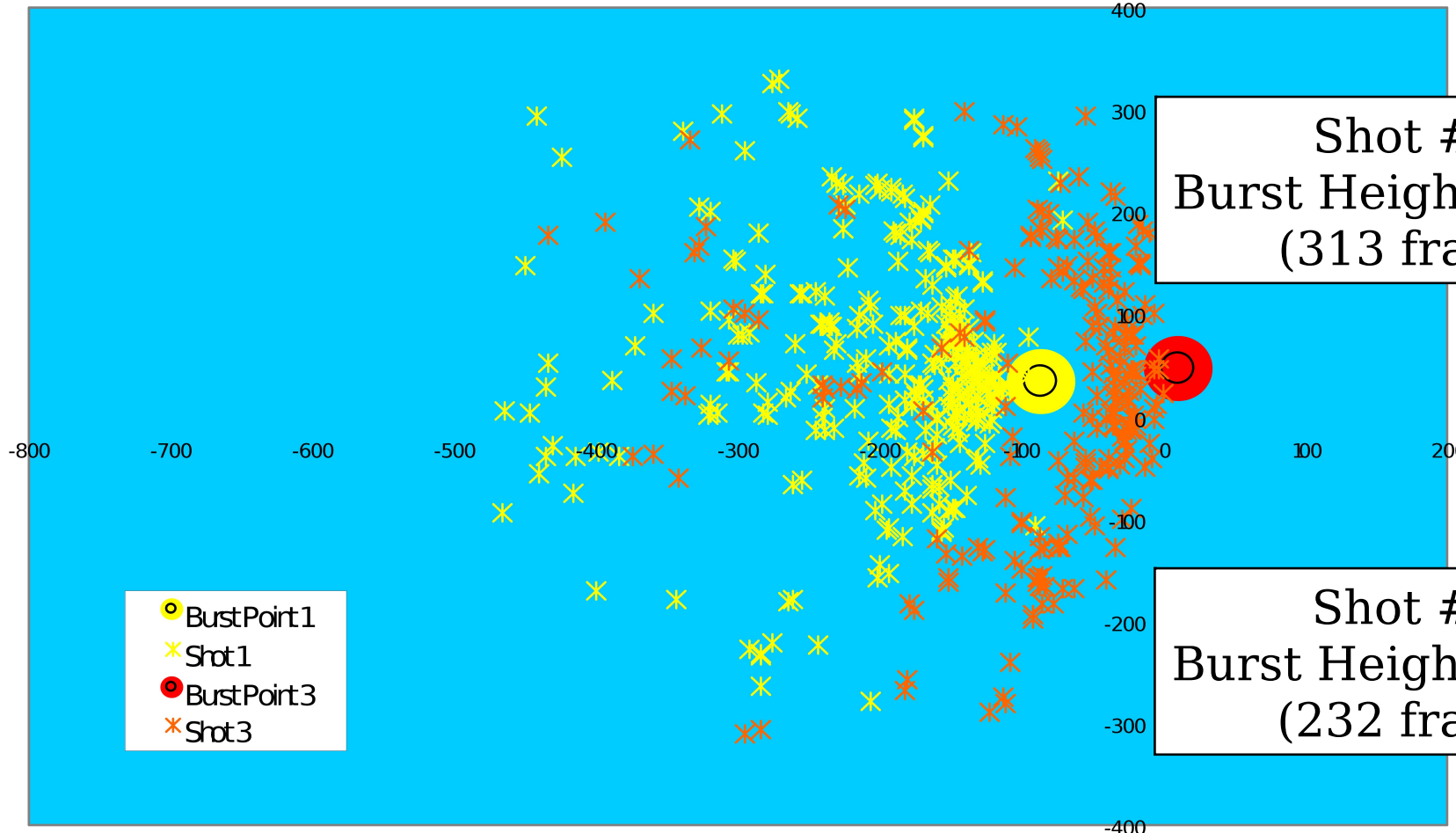
ALACV Super40 HEAB-T

Proof-Of-Principle Test

ALACV Super40 HEAB-T

Proof-Of-Principle Test

Fragmentation Patterns from Shots 1 & 3



Shot #1
Burst Height: 75 in
(313 frags)

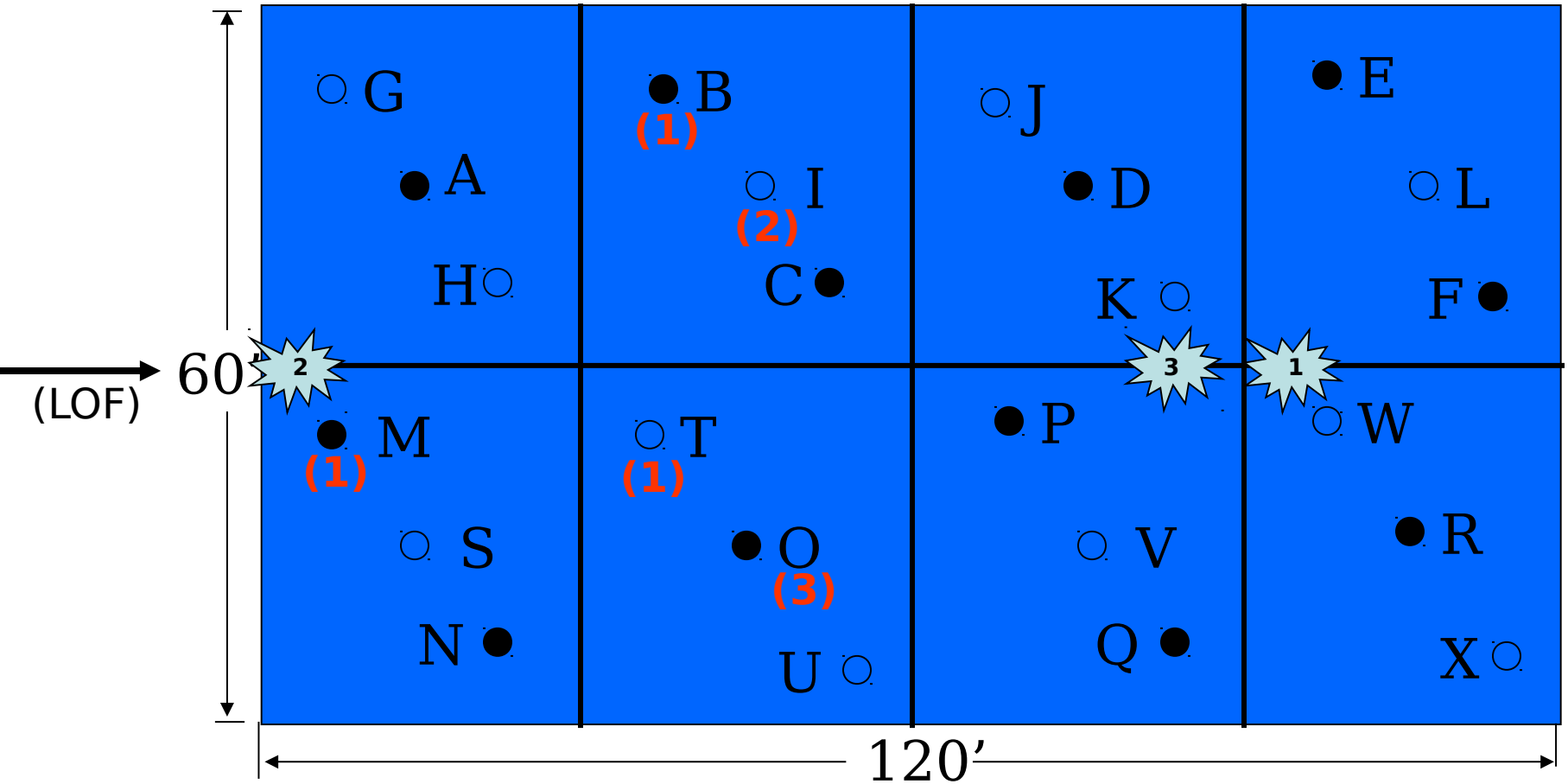
Shot #3
Burst Height: 96 in
(232 frags)

Direction of Fire

ALACV Super40 HEAB-T

Proof-Of-Principle Test

(first three single shot rounds)



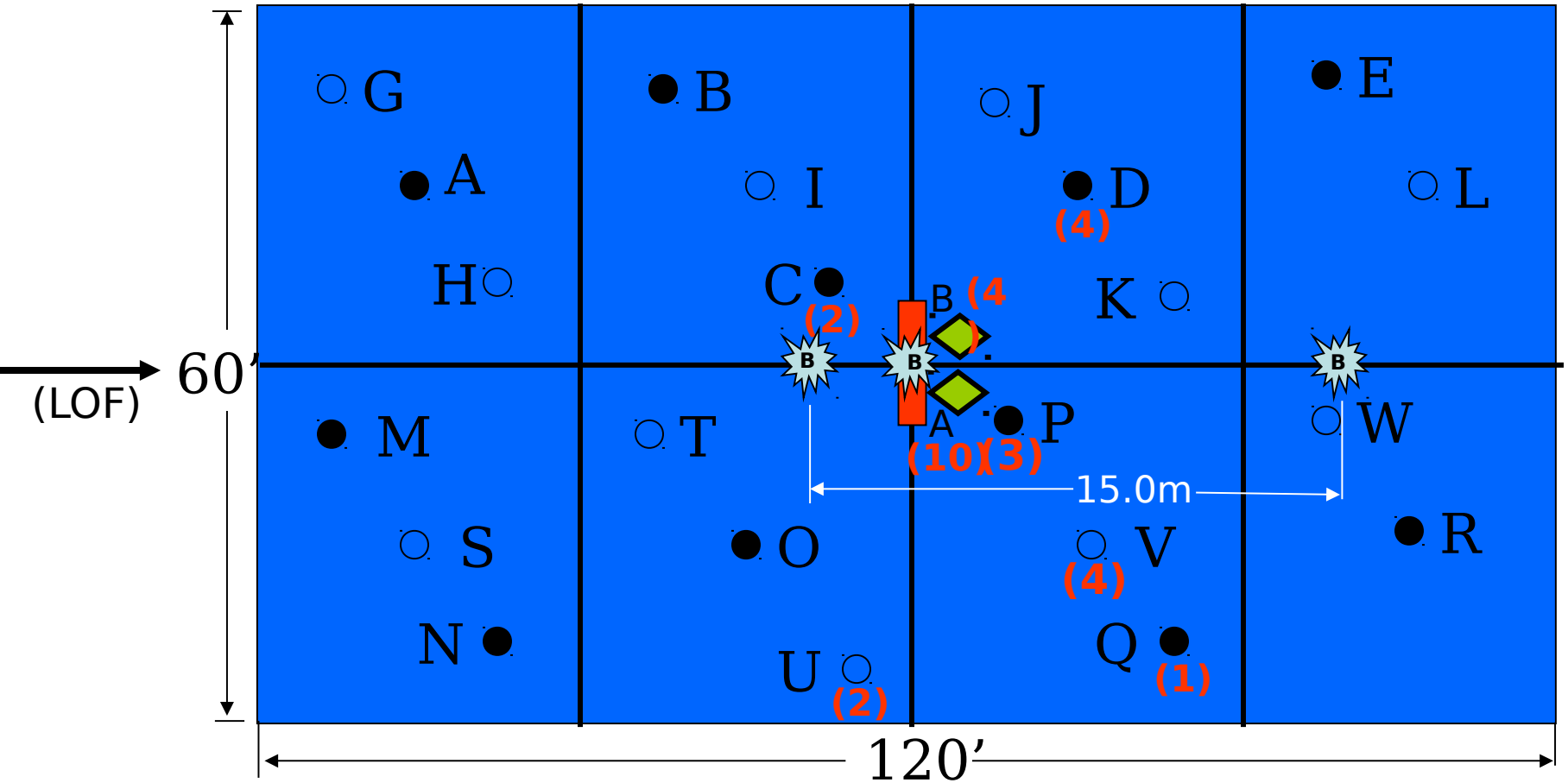
MANNEQUIN TARGET ARRAY

● STANDING ○ PRONE

ALACV Super40 HEAB-T

Proof-Of-Principle Test

(last 3-round burst)



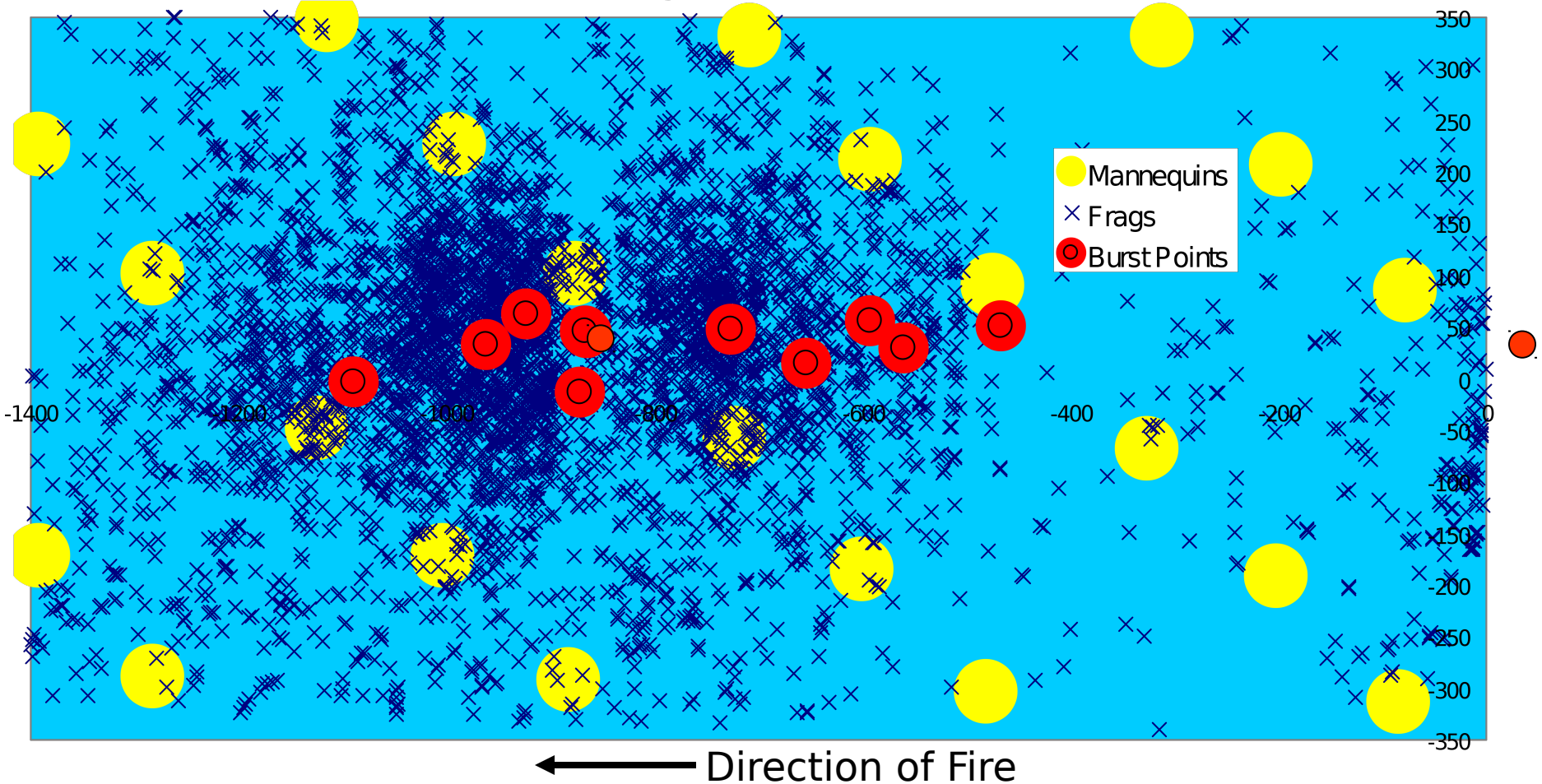
MANNEQUIN TARGET ARRAY

● STANDING ○ PRONE ◆ ATGM (PRONE)

ALACV Super40 HEAB-T

Proof-Of-Principle Test

nulative Fragmentation Footprints from all 12 Roun
5164 Fragment Impacts



ALACV Super40 HEAB-T

Proof-Of-Principle Test

- First Super40 AB-T rounds ever fired with 100% success (12 for
- First Super40 AB-T rounds ever successfully fired from Mk44 Ca
  - both in Single Shot (S/S) & Burst Mode (200spm)
- Demonstrated workable prototype base-mounted fuze
  - Turns-Counter with Command-and-Arm S&A
  - Manually corrected for Ambient Air Pressure and Temperature
  - 2-Day Mean Burst Point: 1525m (1σ range error: 5.3m)
  - Burst Points within 0.1m of predicted ranges
- Mannequin Lethality Data taken on 6 shots over 2-days
  - First 3 in Single Shot, and Last 3 in Burst Mode
  - Total Mannequins hit with Fragmentation over 2-days: 13 of 24
  - Last 3-Round Burst hit 8 of 24 Mannequins in array
    - Total Fragment Impacts on Mannequins: 30
    - 1 prone Mannequin in ATGM site hit 10 times
    - Perforated 6 Kevlar flak jackets and Helmets
- Proven Air Burst rounds are more effective when shot in Burst M

ALACV Program Accomplishments

Programmatically

- First to define the concept of Super40mm ammunition
- First to demonstrate the dual caliber capabilities of the 30/40mm Mk44 Ca
  - First to fire the Mk44 in its Super40 Configuration
  - Successfully fired a 700 gram Air Burst munition at 1000 mps in burst mode

Super40 APFSDS-T

- Increased Behind Armor Effects against latest LAV Targets of Interest
  - Effectiveness was both Range and Target Aspect Dependent
  - Increased P_k at Intermediate Engagement Ranges
  - Decreased P_k at extended Engagement Ranges
- TRL 6 Demonstrated (NOVEL Penetrator fired in a relevant Gun Environmen
- Partial Compliance with STO Exit Criteria

Super40 HEAB-T

- Effectiveness against Dismounted Soldiers unchallenged
  - 470% to 600% improvement over existing 30mm PGU 13B HEPD
- Demonstrated acceptable “burst-point” accuracy with prototype base-fuze
  - 1 σ range error of ± 5m
- TRL 6 Demonstrated (full-up HEAB fired in a relevant Gun Environment)
- Exceeded STO Exit Criteria with the GEN-III Warhead Concept

Where Do We Go From Here?

- Demonstrate GEN-III Enhanced Warheads in a Live Fire T
- Update our M&S capability of the GEN-III Technology
- Scale GEN-III Technology for applicability to 30mm HEAB
- Pursue additional Tech Base Funds to be better prepared a HEAB SDD program in FY07